$$\Rightarrow h^2 + 2m(m\omega^2 - k) = 0 \Rightarrow 2m(m\omega^2 - k) = -h^2$$

$$\Rightarrow m\omega^2 - k = -\frac{h^2}{2m} \Rightarrow m\omega^2 = k - \frac{h^2}{2m}$$

$$\Rightarrow \omega^2 = \frac{k}{m} - \frac{h^2}{2m^2} \Rightarrow \omega_r = \sqrt{\omega_0^2 - \frac{h^2}{2m^2}}$$

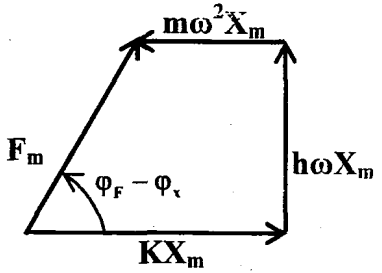
$$\Rightarrow \omega_r < \omega_0$$

$$\omega_r = \sqrt{(30)^2 - \frac{(0,5)^2}{0,02}} = 29,8 \text{rad.s}^{-1}$$

$$x_{m_r} = \frac{F_m}{\sqrt{h^2\omega_r^2 + \left(m\omega_r^2 - k\right)^2}}$$

$$= \frac{4,5}{\sqrt{0,25(29,8)^2 + \left(0,1.29,8^2 - 90\right)^2}} = 0,3\text{m}$$

$\omega_r < \omega_0$



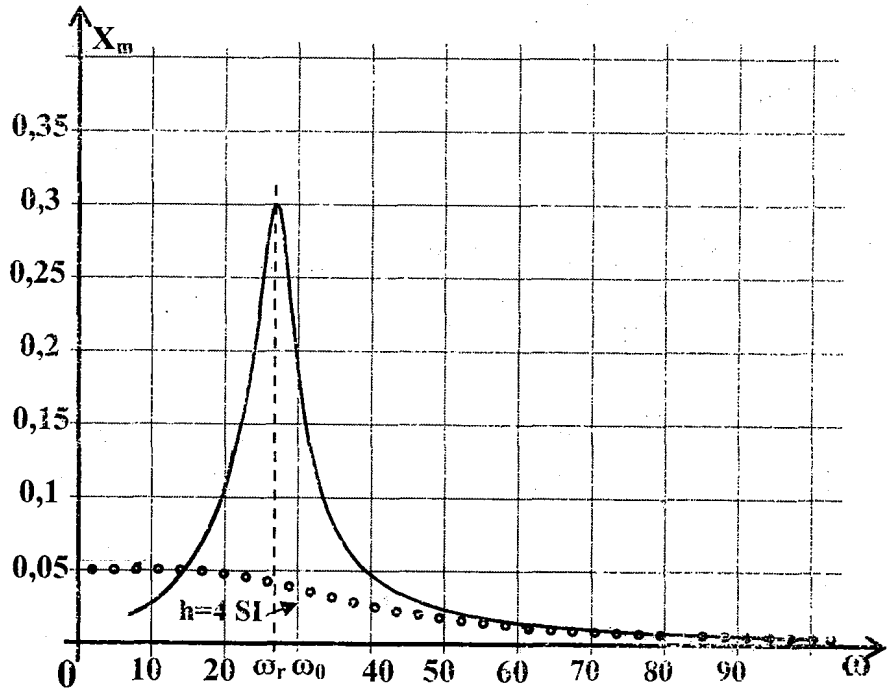
$$tg(\varphi_f - \varphi_x) = \frac{h\omega_r}{k - m\omega_r^2} = \frac{0,5.29,8}{90 - 0,1(29,8)^2}$$

$$\varphi_F - \varphi_x = 1,45 \text{ rad}$$

$$\varphi_x = -1,45 \text{ rad}$$

pour $h = 4\text{kg.s}^{-1}$

$$\begin{cases} \omega_r' = \sqrt{30^2 - \dfrac{16}{0,02}} = 10 \text{ rads} \\ x'_{m_r} = \dfrac{4,5}{\sqrt{0,16 \times 100 + (10-90)^2}} = 0,056\text{m} \end{cases}$$



Remarque :

Pour qu'il y a phénomène de résonance il faut que